DOCUMENT RESUME

ED 160 443 **SE 025 082**

AUTHOR	Myers, Arthur L.
TITLE	Weed Control Sprayers: Calibration and Maintenance. Special Circular 81.
INSTITUTION	Pennsylvania State Univ., University Park. Coll. of Agriculture.; Pennsylvania State Univ., University Park. Cooperative Extension Service.
PUB DATE	[78]
NOTE	21p.; Photographs may not reproduce well
EDRS PRICE	MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS	*Agricultural Chemical Occupations; *Agricultural Machinery; Agriculture; *Herbicides; Science Education; *Weeds

ABSTRACT

This manual covers aspects of calibration and maintenance of weed control sprayers including variables affecting application rate, the pre-calibration check, calculations, hand spraying, nozzle tip selection, agitation, and cleaning. (BB)

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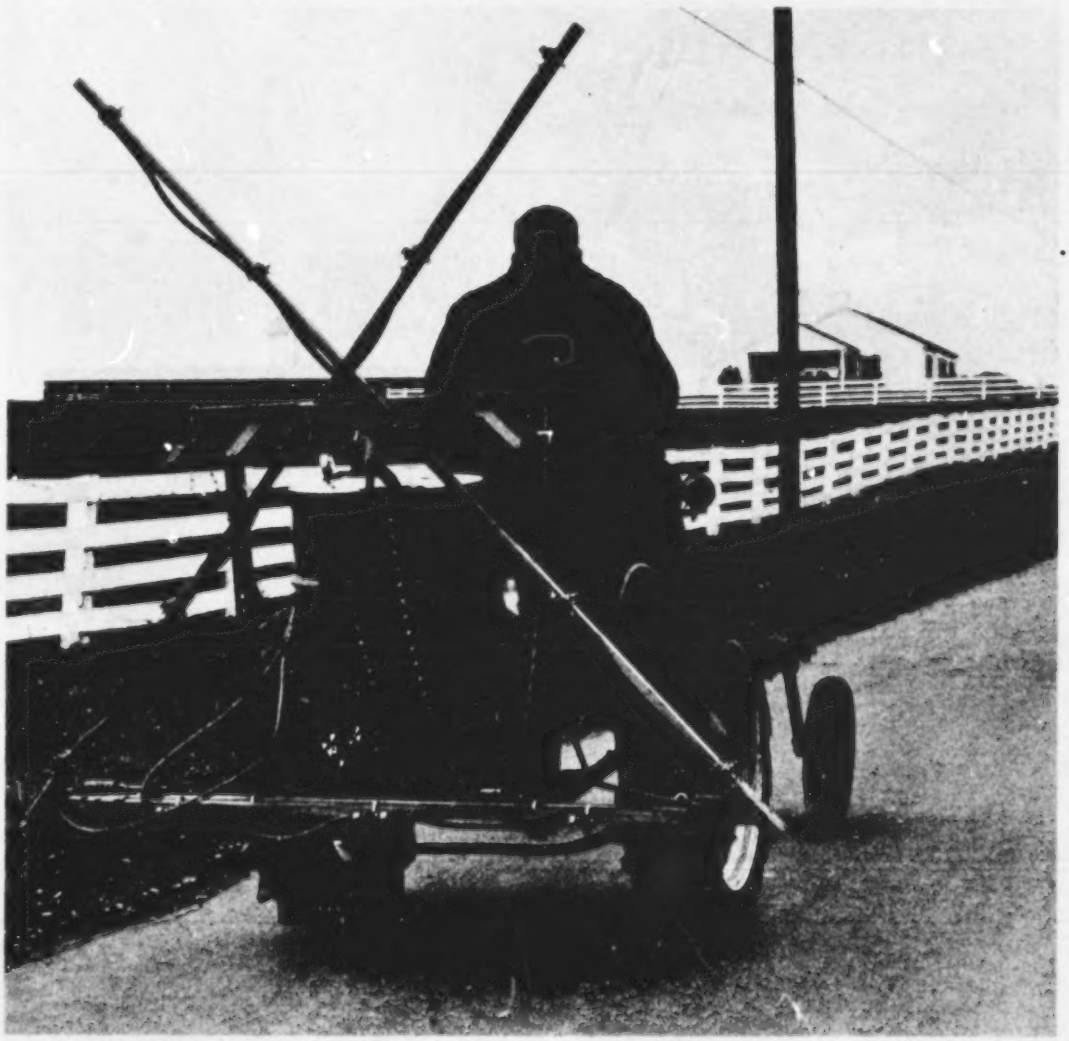
Agricultural and Home Economics Extension Service of The Pennsylvania State University, the United States Department of Agriculture cooperating. T. H. Patton, Director. Distributed in furtherance of Acts of Congress May 8 and June 30, 1914.

A simple weed sprayer rig with 55-gallon drum spray tank and folding booms for traveling between fields.



Weed Control Sprayers
calibration and maintenance

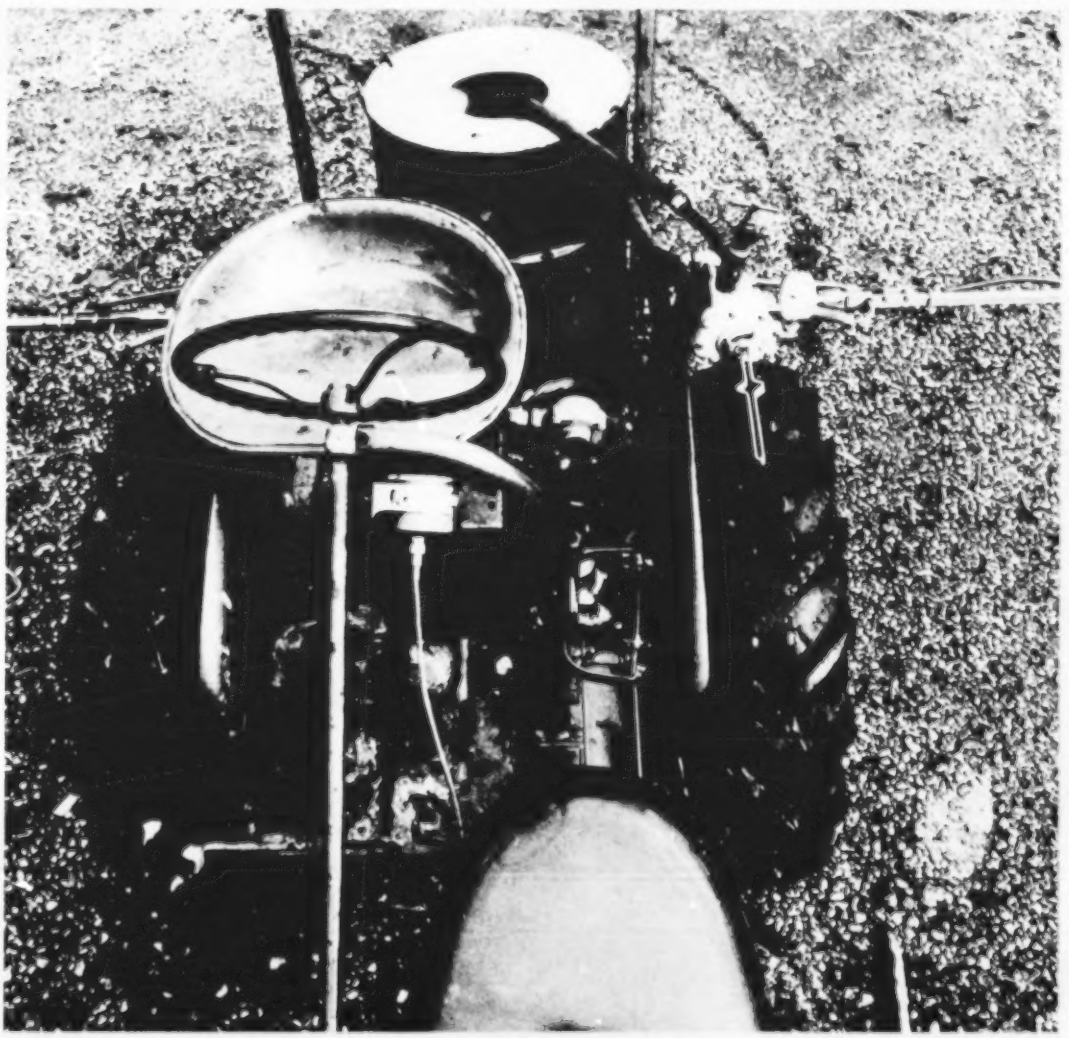
A sprayer will successfully do the job you want when attention is given to the details of calibration and maintenance.

A sprayer must be calibrated, and the proper nozzle tip used, if you are to apply the correct amount of material per acre. For uniform application, and to prevent nozzle plugging, it may often be necessary to maintain agitation of the material in the tank. This is especially necessary with wettable powders which tend to settle out. Cleaning between sprayings will preserve the equipment, improve its functioning, and prevent the chance mixing of incompatible chemicals, or applying traces of the wrong chemical.

In field spraying, either the broadcast or band method may be used. With broadcast spraying, the chemical is delivered in such a way as to equally cover every bit of soil. In band spraying, the pesticide is applied in bands with unsprayed strips left in between.

For each spraying job it is important to know the exact amount of chemical your sprayer will apply. If insufficient chemical is applied, you may not obtain the desired results. If you apply too much material, money is wasted, crops can be badly damaged, and excessive residues on plants or in the soil can make feed unusable and food plants unmarketable.

Mounted on tractor, important sprayer components seen are tank and booms, pressure regulator and g··ge, and pump.



Calibration

Variables Affecting Application Rate

Calibration of your sprayer is essential to determine how much chemical will be applied. Speed, pressure, nozzle orifices and spacing, and the viscosity of the material affect application rate.

Speed—The speed of the sprayer over the ground should be held constant. Best results will occur at 3 to 5 miles per hour. The speed at which you will spray should be kept in mind when adjusting the other variables. If the speed when applying spray material is greater than that used for calibration, fewer gallons per acre will be applied. If the speed is less, then more gallons per acre will be used. For example, if you calibrate your sprayer for 4 mph but apply the chemical at 6 mph, you would apply only two-thirds of the desired amount.

Pressure—Amount of flow relates directly to pressure. Hence, pressure also should be held constant. More pressure increases the number of gallons used per acre, while less pressure decreases the amount applied. Furthermore, increasing the pressure will produce smaller spray droplets, increasing the possibility of drift. Pressure usually is regulated by a pressure regulator or relief-bypass valve.

Nozzle Opening—With pressure constant, generally the larger the nozzle opening, the greater the amount of pesticide that will be applied to the same area. Smaller nozzle openings will deliver smaller amounts. The shape of the opening determines the pattern in which the spray will be applied. Instructions accompanying the chemical you have selected recommend proper nozzle size and shape.

Nozzle screens and tips are cleaned in a detergent solution with a soft bristle brush.

Nozzle Spacing—On most sprayers the nozzle spacing is fixed. But if nozzles are adjustable, moving them closer together will increase the amount of chemical applied the same area. Moving them farther apart will decrease the amount applied.

Nozzle Wear—Accurate calibration is difficult if nozzles are worn. Abrasive solutions such as wettable powders can cause nozzles to wear rapidly. If abrasive solutions are often used, harder nozzle tips and more frequent calibration are necessary.

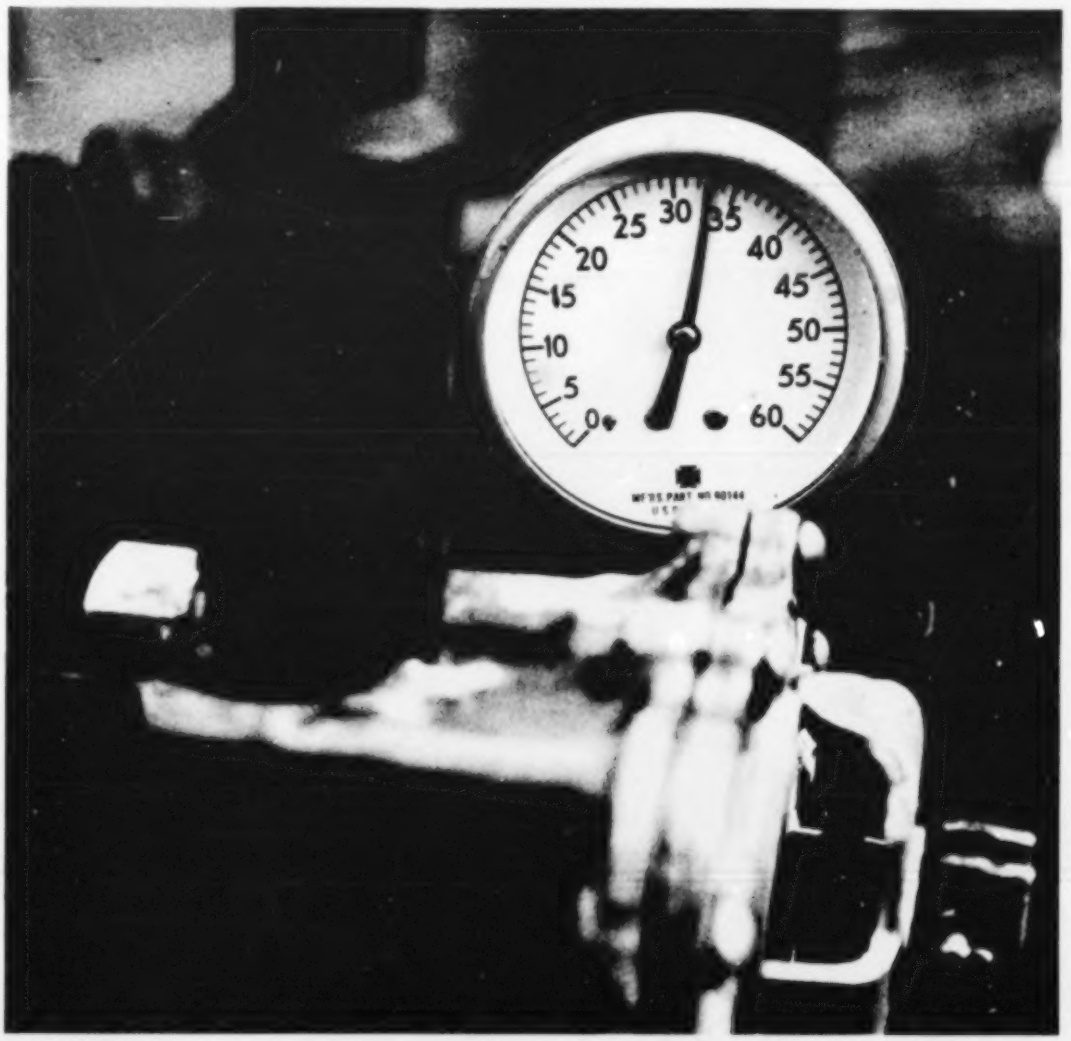
Viscosity—Sprayers are usually calibrated with water. But if the viscosity of the spray material is considerably different than water, calibrate with the liquid that will be used in spraying. Generally, wettable powder solutions have a higher viscosity than water; oil-base solutions have a lower viscosity. Hence, if you calibrate with water and apply a wettable powder solution, the amount of spray delivered will be less than you figured. If you apply an oil-base solution, the application rate will be greater.

Pre-calibration Check

Several methods can be used satisfactorily to calibrate a sprayer. Select the method that suits you best. Regardless of the method, you should first make the following inspections:

1. Check the operating parts of your sprayer to make sure they are functioning properly. Repair or replace malfunctioning parts before proceeding with calibration.
2. Be sure nozzle tips and screens are clean.

Pressure must be held the same during calibration and actual spraying.



If they are dirty, clean them with kerosene or laundry detergent. Use an old toothbrush or any other soft-bristle brush. Do not use any metallic device, such as a knife or wire; it will damage the nozzle tips and screens.

3. Be sure nozzle tips and screens are the correct size and shape for your particular spraying job. Follow the instructions with the chemical you have selected and also the operating instructions for the sprayer. These will be a big help in selecting the right nozzle tip and screens. Your spray equipment dealer should be able to supply the types you need.

4. Check nozzle tips by placing containers of the same size and shape under each nozzle and operating the sprayer. If some containers fill faster than others, look for nozzle wear. Replace worn nozzle tips with new ones. If wear is not the cause of an uneven flow, check again for plugging in the nozzle tips and screens.

Calibration Methods

Procedures described below are based on broadcast spraying. Modifications for band spraying are described in a later section.

Calibration Jar—Follow instructions that come with the jar. Lay out a short, measured course, attach the jar under one of the nozzles, and drive the course at a certain speed and pressure. The application rate in gallons per acre can be read directly from the jar. Be accurate in your speed and pressure measurements, and in your jar reading. You are collecting less than a quart of liquid to measure an application of 10 or more gallons per acre. A difference of several graduations in

The tachometer reading noted during calibration must be used when actually spraying.

liquid level caused by misreading or holding the jar at an angle, plus differences in speed or pressure from those specified, can cause an error of several gallons per acre in interpretation of the reading.

Full Tank—Fill your sprayer tank with a normal load of water. Measure the number of gallons in the tank, if you do not know its capacity. Use a calibrated stick, markings on the tank, or a sight gauge. Spray as you normally would until the tank is empty. Measure the area covered. Then figure your pesticide requirements accordingly.

For example, assume that 88 gallons normally fills your tank. If one tankful covers 5½ acres, and recommended amount of chemical per acre is 2 pounds, place 11 pounds (2 x 5½) of chemical in the full tank.

The amount of chemical required is in direct proportion to the amount of water used. If the job requires spraying less or more than 5½ acres, further calculations are necessary. First of all, compute the number of gallons required to cover 1 acre (gal/acre):

$$\text{gal/acre} = \frac{\text{gallons in full tank}}{\text{number of acres sprayed}} \text{ or } \frac{88}{5\frac{1}{2}} = 16$$

The total number of gallons required to do the job is calculated by multiplying the number of acres to be sprayed by the gal/acre. The number of acres times the amount of recommended chemical per acre equals the total amount of chemical needed.

A measuring can is used to refill the tank after making the calibration run.

For example, assume the job calls for spraying 22 acres. How many gallons of water, and how many pounds of chemical will be needed? Using the figures above, total gallons required is 22 x 16 = 352. Total chemical needed is 22 x 2 = 44 pounds. Since your sprayer tank holds 88 gallons when full, how many tankfuls will be required to complete the job? The answer is (352 ÷ 88), or 4 tankfuls.

Measured Course—Choose the length of the course for convenience in measuring and calculating. The width is determined by the boom length. Some farmers prefer a course length corresponding to a full acre, while others may prefer a length fixed in round numbers for ease in calculation. Regardless of the size of the course, the procedure is the same:

1. Lay out the course that suits you best, preferably in the area to be sprayed. Table I can be used to convert acres to course length for the length of your sprayer boom.

2. Select the ground speed you will use for the spraying. Then note the tachometer reading for the speed selected.

3. Level the sprayer tank and fill it to a pre-set mark.

4. Make your calibration run. Be sure to turn on spray at exact start of the course, and turn it off at the exact end of the course.

5. Find the number of gallons used by measuring the number of gallons of water needed to refill the tank to the mark.

6. Using the number of gallons obtained in step 5, calculate gal/acre the sprayer delivers.

If you used a full-acre course, gal/acre is the same as the number of gallons used. If you used

The application rate in gallons per acre can be read directly from the calibration jar.

TABLE 1

Course Length Table

Boom length in feet	Course length in feet for ¼ acre	⅛ acre	1 acre
10	1,089	2,178	4,356
12	908	1,815	3,630
14	778	1,556	3,112
16	681	1,361	2,722
18	605	1,210	2,420
20	545	1,089	2,178
22	495	990	1,980
24	454	908	1,815
26	419	838	1,675
28	389	778	1,556
30	363	726	1,452
32	340	681	1,361
34	320	641	1,281

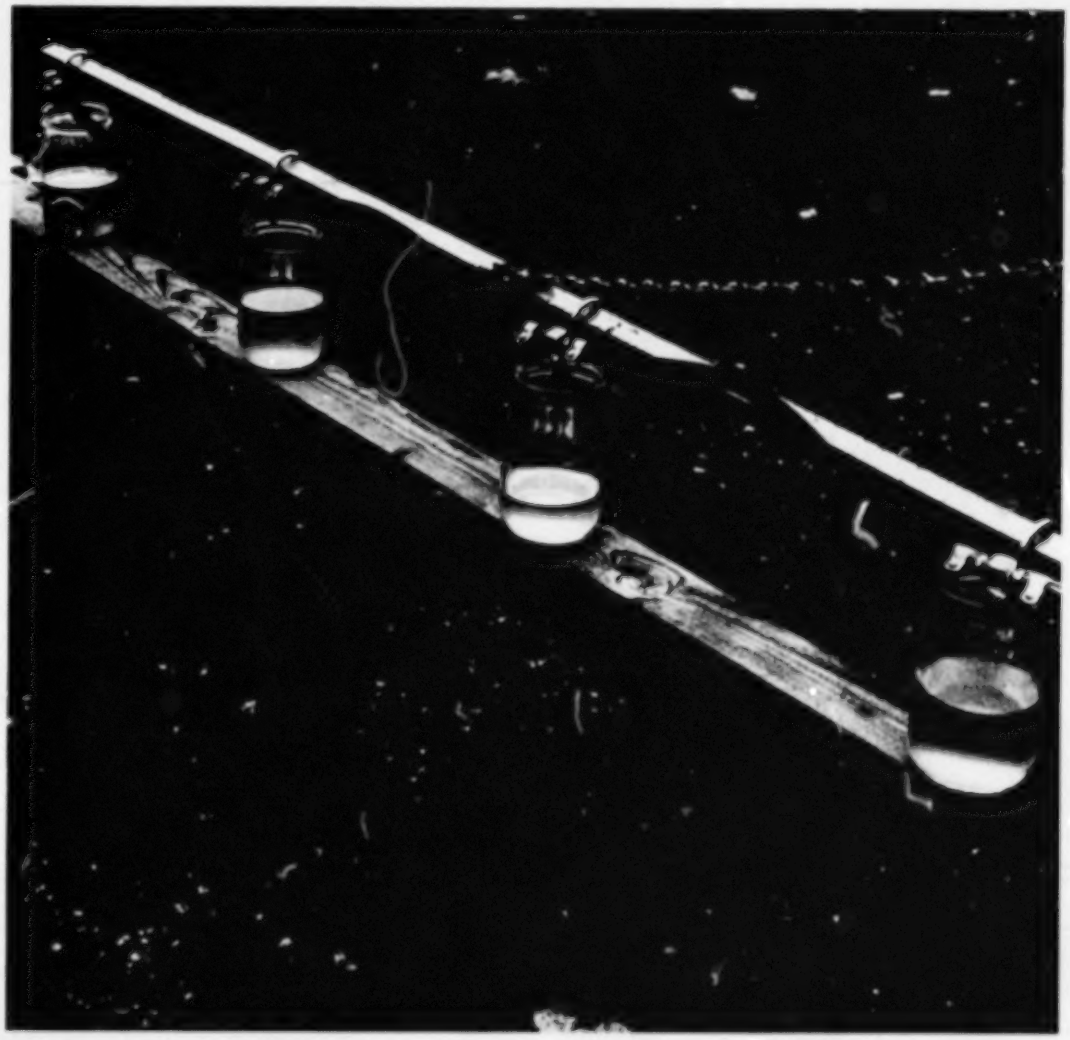
a course length corresponding to a fraction of an acre, gal/acre equals the gallons used multipled by the reciprocal of the fraction. For example, if you used a ¼-acre course, gal/acre is equal to the gallons used times 4; similarly, for ⅛-acre course, multiply by 2. If you use some other course length, gal/acre can be calculated by using the following formula:

$$\text{gal/acre} = \frac{\text{gallons used} \times 43{,}560}{\text{boom length} \times \text{course length (in feet)}}$$

To *increase* gal/acre, use one or more of the following adjustments: substitute larger nozzle tips, decrease ground speed, increase pressure.

To *decrease* gal/acre, use smaller nozzle tips, increase the ground speed, and/or decrease pressure.

Defective nozzle tip shows up in check for equal flow using identical containers.



Band Spraying

Calibration methods described above also apply to band spraying, with the following exceptions:

If your calibration jar is not graduated for band spraying, avoid this method of calibration unless a correction factor is used.

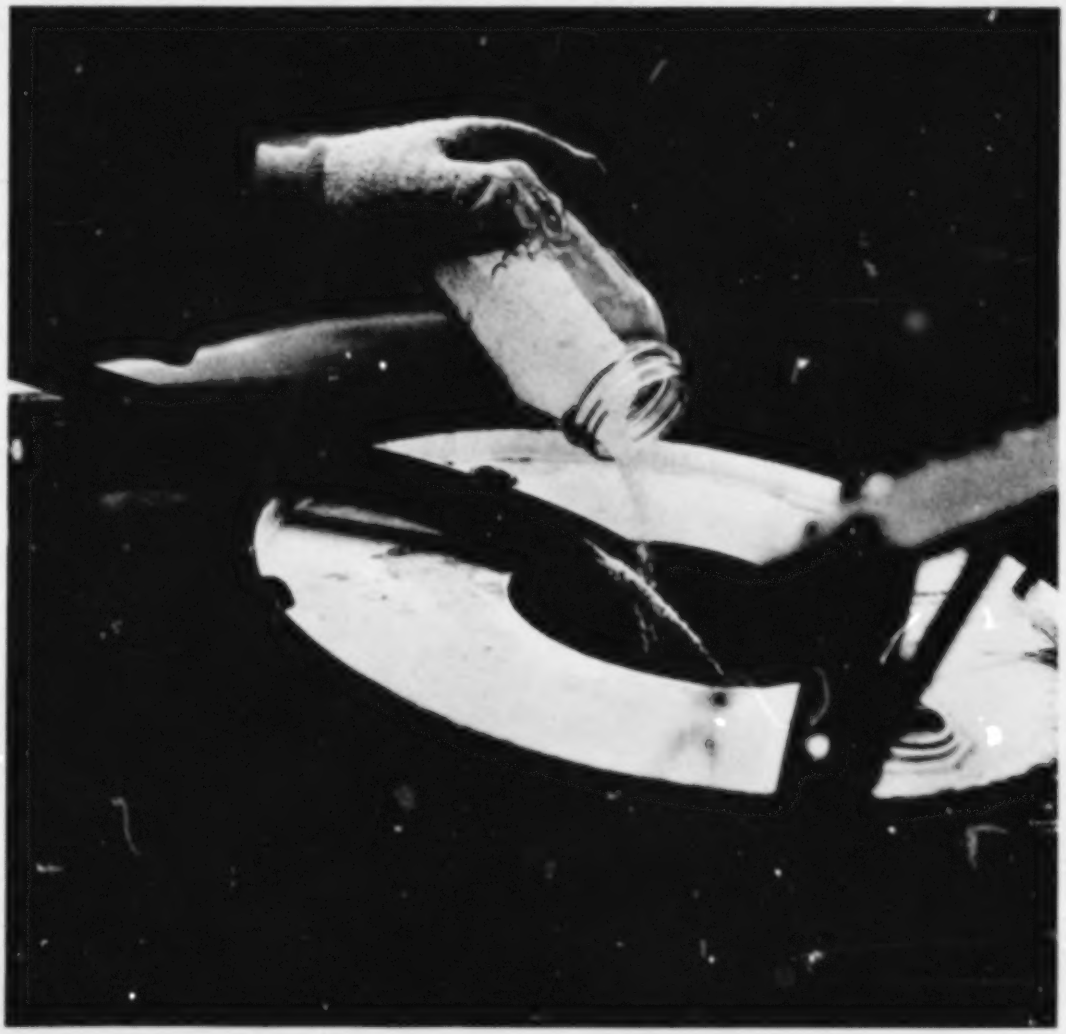
Recommended rates of application and data given in nozzle tip selection tables by manufacturers are for broadcast spraying and must be adjusted for band spraying. For example, in band spraying 12-inch bands on 36-inch corn rows, approximately one-third of the ground surface covered in broadcast spraying is treated; the actual amount of chemical applied is the ratio of the band width to the row spacing (12/36 = 1/3). Gallons per acre applied in band spraying can be calculated by using the same formula:

$$\text{gal/acre (band)} = \text{gal/acre (broadcast)} \times \frac{\text{band width (in inches)}}{\text{row spacing (in inches)}}$$

For example, if the recommended broadcast spray rate is 3 pounds of chemical in 20 gallons of water per acre, and you spray a 12-inch band on 36-inch rows, the actual amount of spray you should apply per acre will be 1 pound of chemical in 6⅔ gallons of water (20 x 12 ÷ 36 = 6⅔ gal).

When boom length is needed for figuring, use the length obtained by multiplying the number of nozzles by the row spacing in feet. For example, if your sprayer has four nozzles and the row spacing is 20 inches (1⅔ feet), the boom length will be the product of 4 x 1⅔, or 6⅔ feet.

The area to be covered determines the amount of chemical to be added in proportion to water.



Example—A band sprayer attachment, with a tank capacity of 50 gallons, was used on a four-row corn planter. Sprayer band width — 12 inches. Corn row spacing — 36 inches. Spraying four bands, a 12-foot swath was covered.

Recommended dosage and dilution (broadcast application) for the chemical in question was 3 pounds per acre in at least 20 gallons of water.

With a full tank of water, a course 908 feet long was sprayed at 4 mph. The tank was refilled, and the amount of water used measured 2 gallons.

Calculate the amount of water per acre the sprayer actually applied:

$$\frac{\text{gal used} \times 43{,}560}{\text{broom length} \times \text{course length}} = \frac{2 \times 43{,}560}{12 \times 908} = 8 \text{ gal/acre}$$

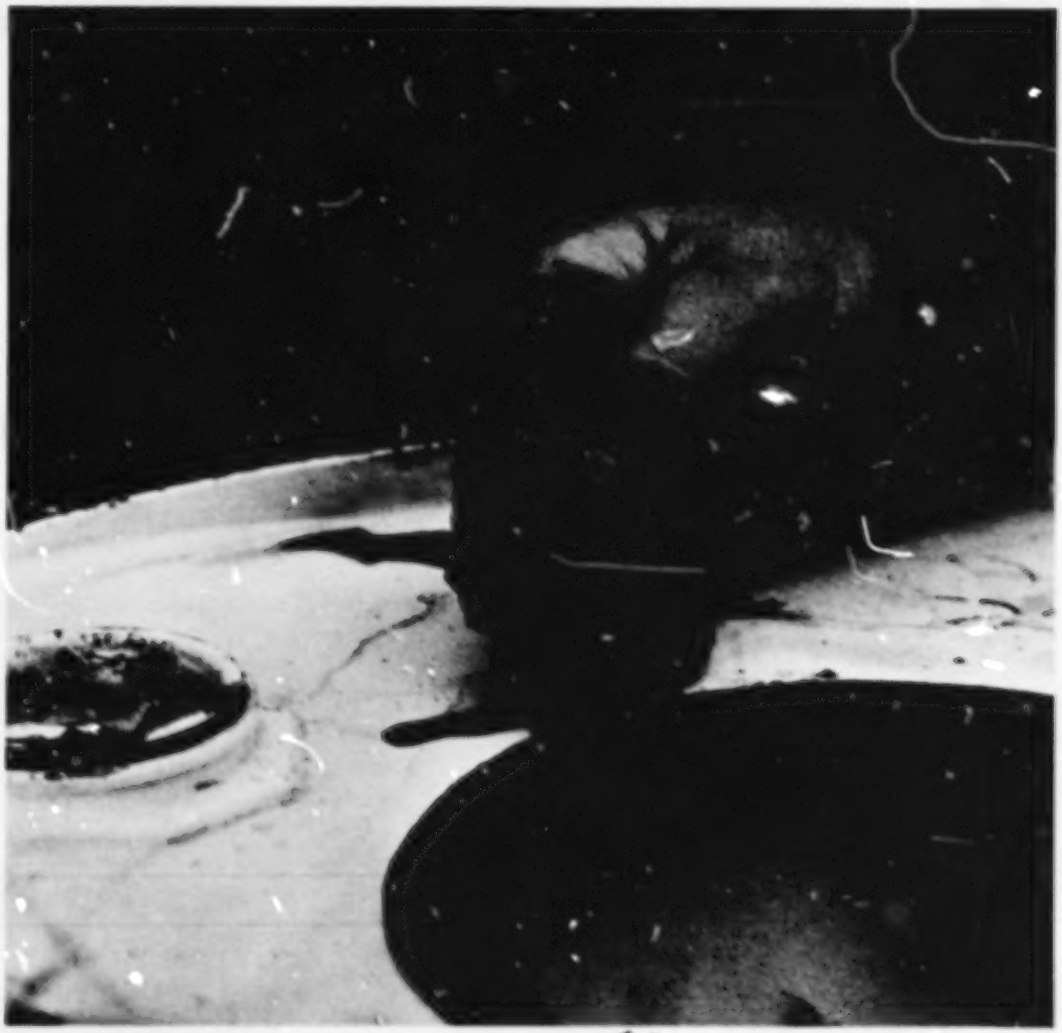
Calculate the minimum amount of water needed for band application:

$$\frac{\text{band width}}{\text{row spacing}} \times \text{gal/acre (broadcast)} = \frac{12"}{36"} \times 20 = 6\tfrac{2}{3} \text{ gal/acre}$$

Calculate the amount of chemical to use for band application:

$$\frac{\text{band width}}{\text{row spacing}} \times \text{lbs. chem. per acre (broadcast rate)} = \frac{12"}{36"} \times 3 = 1 \text{ lb/acre}$$

Wettable powders will settle out and form sludge in the tank if agitation is not maintained.



Since the recommended minimum amount of water for band spraying was 6⅔ gal/acre and the sprayer applied 8 gal/acre, the amount was adequate.

Since the required amount of chemical for band spraying was 1 lb/acre and this sprayer (with a 50-gallon tank capacity) applied 8 gallons of water per acre, 6¼ acres could be covered with a full tank (50 ÷ 8 = 6¼).

If the amount of water applied were inadequate — in this case, less than 6⅔ gal/acre — then nozzle openings must be enlarged, or pressure increased, or speed reduced, and the equipment retested until the application rate is adequate. Then calculate the amount of chemical to add to the tank on the basis of the number of gallons of water per acre, band rate, determined during the rerun.

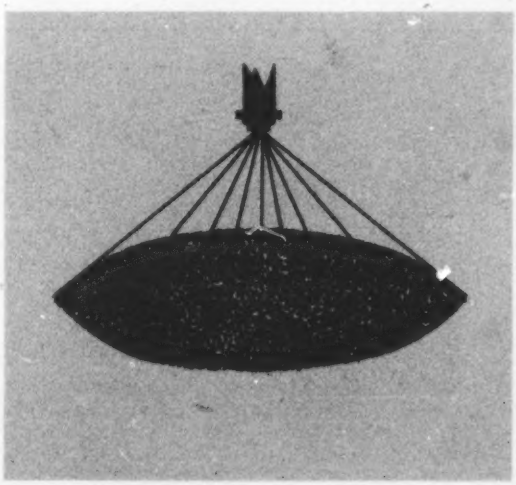
Nozzle Tip Selection

Types

Many different types and sizes of nozzle tips can be used on your sprayer. The more commonly used tips are shown in Fig. 1.

The flat fan nozzle, which sprays an oval pattern, is best for broadcast spraying where uniform field application is required. For band spraying, usually pre-emergence, the even flat fan type, which sprays a rectangular pattern, is preferred. Cone nozzles are best for applying insecticides, because they provide better coverage of the infested plant parts. Hollow cones are used to deliver low-volume sprays, and solid cones are used for high-volume applications.

The boomless sprayer should be used only when accurate placement and uniform coverage



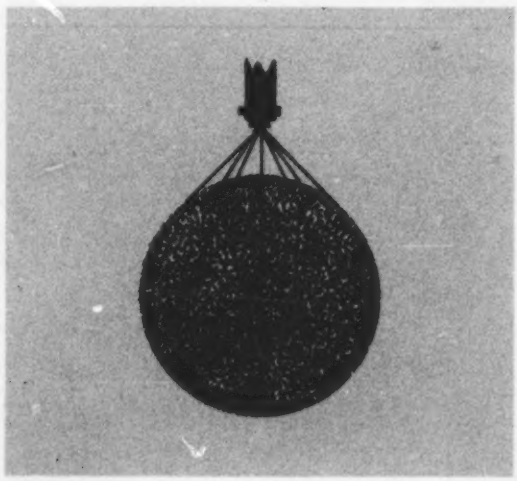
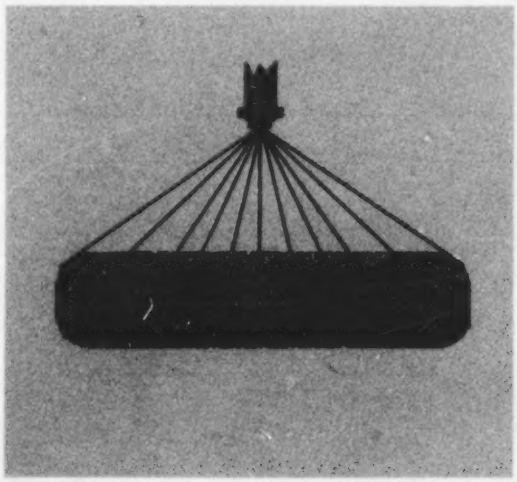
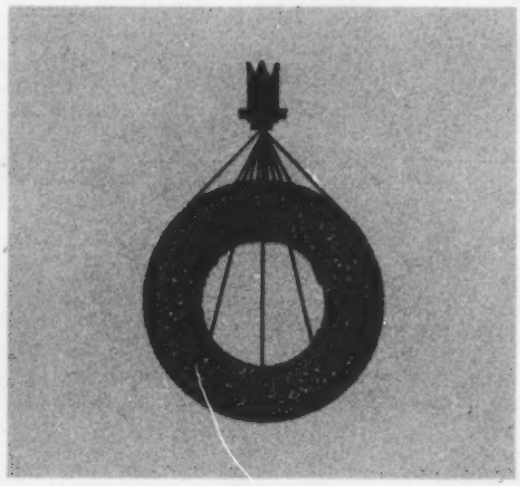


FIG. 1—Four commonly used nozzle tips.

Flat Fan
Even Flat Fan
Solid Cone
Hollow Cone





are not required. The slightest air motion affects the spray pattern, making it difficult to match swaths and to get good coverage with the relatively coarse droplets at the outer end of the swaths.

Sizes

The nozzle tip size is selected according to gallons per acre, pressure, ground speed, and nozzle spacing. For application rates of 10 or 20 gallons per acre, nozzle tip sizes can be selected from Table II. For other rates it is necessary to use the manufacturer's nozzle tip selection tables.

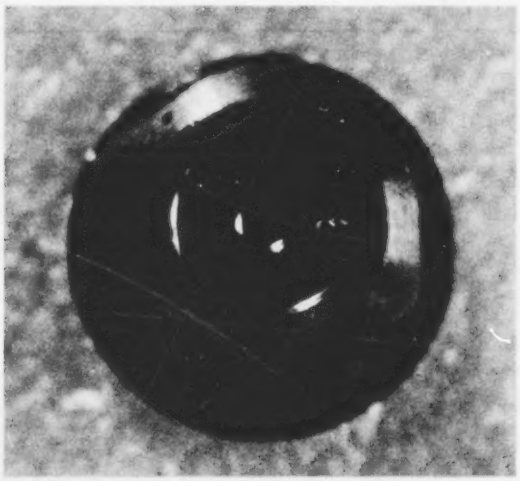
Height

To obtain uniform application in broadcast spraying, you must operate the nozzles at the proper height above the crop. The correct heights for various angles of spray patterns are listed in Table III. If nozzles are operated at an incorrect height, alternate strips of high and low spray concentrations can result, weed control may be less effective, and damage to the crop may occur. It is also necessary for each nozzle tip to be adjusted so the spray pattern will be in line with the boom to avoid applying alternate bands of high and low concentrations.

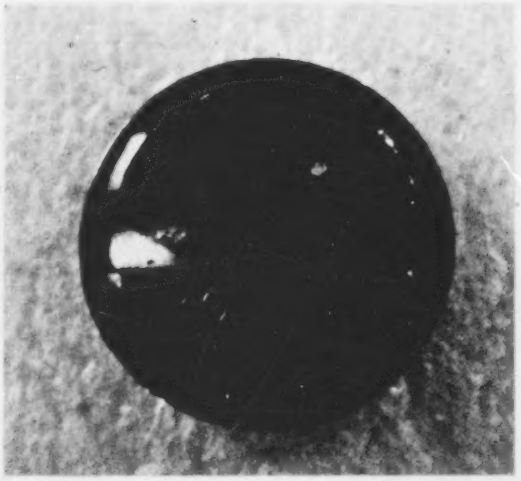
Strainers

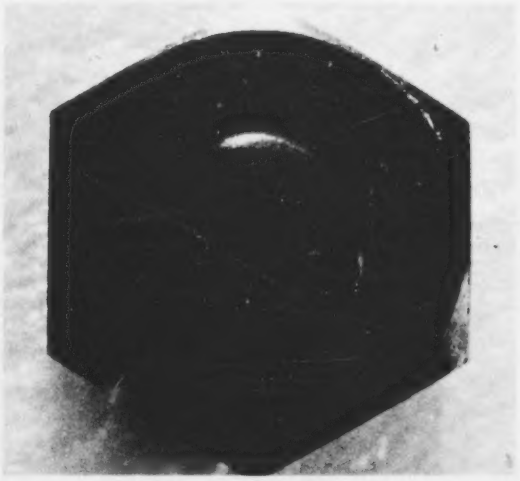
Always use a screen in each nozzle to prevent plugging of tips. A strainer also should be used in the suction line of the pump. An additional strainer also may be used in the line between the

Flat Fan
Even Flat Fan



Solid Cone
Hollow Cone





pump and the boom. These strainers should be matched according to the size of the nozzle tip opening.

Screens are selected on the basis of their mesh — the number of openings per inch. A 100-mesh screen will have smaller openings than a 50-mesh screen since it has twice the number of openings per inch.

When you apply emulsifiable liquids or soluble liquid formulations as a water spray at a rate of 10 or less gal/acre, a fine (100 mesh) screen should be used in the nozzle tip. A coarser screen, such as 50 mesh, may be used in the suction strainer. When you apply wettable powders or other materials at a rate of 20 or more gal/acre, a coarse (50 mesh) screen should be used in the nozzle tip. Coarser suction strainers may be designed as holes or slits in a metal cup.

TABLE II

Sprayer Nozzle Tip Selector

	3 Miles Per Hour		4 Miles Per Hour		5 Miles Per Hour	
Manufacturer	Tip No.	Psi	Tip No.	Psi	Tip No.	Psi
To apply 20 gallons per acre, use the following tips						
Teejet	8002	40	8003	33	8004	28
Sprajet	80.2	40	80.3	33	80.4	28
Delavan	FS5	40	FS6	39	FS7	41
			FS7	26	FS8	27
Century	•		Fx20	35	•	
Monarch	39	30	46	37	46	60
Hydro-Speed	4	25	5	28	•	
To apply 10 gallons per acre, use the following tips						
Teejet	8001	40	80015	32	8002	28
Sprajet	80.1	40	80.15	32	80.2	28
Delavan	FS3	36	FS4	37	FS5	27
Century	•		Fx10	35	•	
Monarch	28	40	32	43	35	44
Hydro-Speed	1	25	2	46	•	

Rates are based on new tips using water and 20-inch nozzle spacing.

Teejet, Sprajet, and Delavan are 80° pattern—operate at 17″-19″ height.

Century is 73° pattern and Monarch is 70° pattern—operate at 20″-22″ height.

If check valves are used, increase pressures for Teejet and Delavan by 5 psi and for Sprajet and Monarch by 10 psi.

•Manufacturer's recommendations not available.

Agitation

Types of Spray Materials

Spray materials usually are made to be mixed in water before being applied. There are several basic types of spray materials, such as emulsifiable liquids, soluble liquids, wettable powders, and soluble powders. In addition, these four basic types have different variations.

When an emulsifiable liquid is added to water in a spray tank, an emulsion results. An emulsion is a suspension of the particles of one liquid with those of another — for example, oil dispersed in water. Most oils will not suspend well in water, so another ingredient is added as an emulsifier. Emulsions will usually separate if not agitated.

Soluble powders and liquids are compounds

TABLE III

Nozzle Heights for Spray Pattern Angles

Spray pattern angle	Nozzle height above crop
65°	21″ to 23″
70°	20″ to 22″
80°	17″ to 19″
90°	15″ to 17″

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that will dissolve in water to form a true solution — for example, sugar mixed with water. Once dissolved, the granules will not separate or settle out.

Wettable powders are insoluble in water, but are treated with a wetting agent so they will form a suspension. They are composed of millions of tiny particles which will suspend in water like fine mud or silt, but will settle out if not agitated.

Methods of Agitation

Agitation can be mechanical or hydraulic. Mechanical agitation is accomplished by paddles or a propeller revolving in the tank. Hydraulic agitation is accomplished by discharging some of the spray solution back into the tank. This is done by diverting flow through the bypass or through a jet agitator; some systems use an additional pump.

Agitation with the flow from the bypass regulator is sufficient for the mild stirring required to maintain emulsions and solutions containing adequate emulsifiers. But greater agitation is required for wettable powders and solutions without emulsifiers.

Jet agitation is inexpensive, easy to install, and does a satisfactory job when properly used. Fig. 2 shows how to place the agitation jets in a horizontal cylindrical tank for best results. Fig. 3 shows the jet installation for a vertical barrel. Note that a separate line is run from the discharge side of the pump to provide the agitation. Unsatisfactory jet agitation ordinarily results from using the discharge from the bypass line of

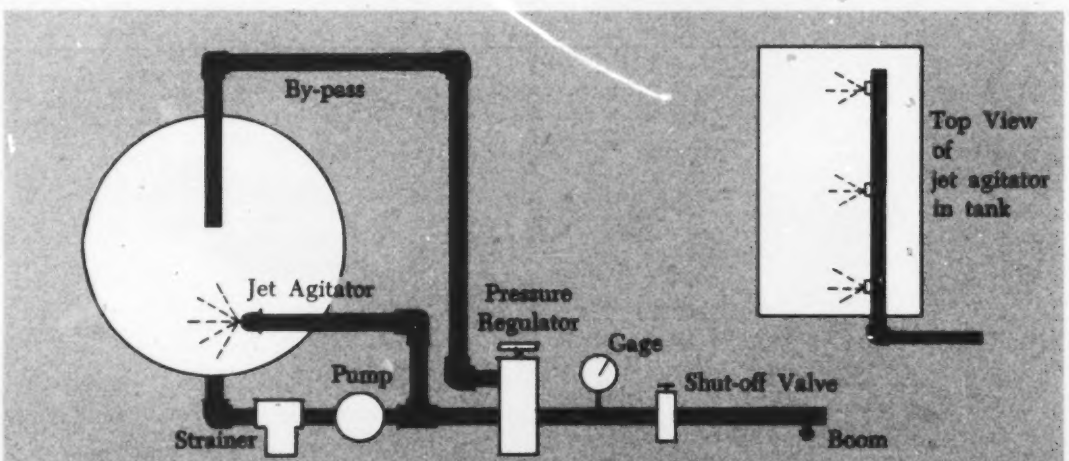


FIG. 2—Location of jet agitator in sprayer with horizontal tank.

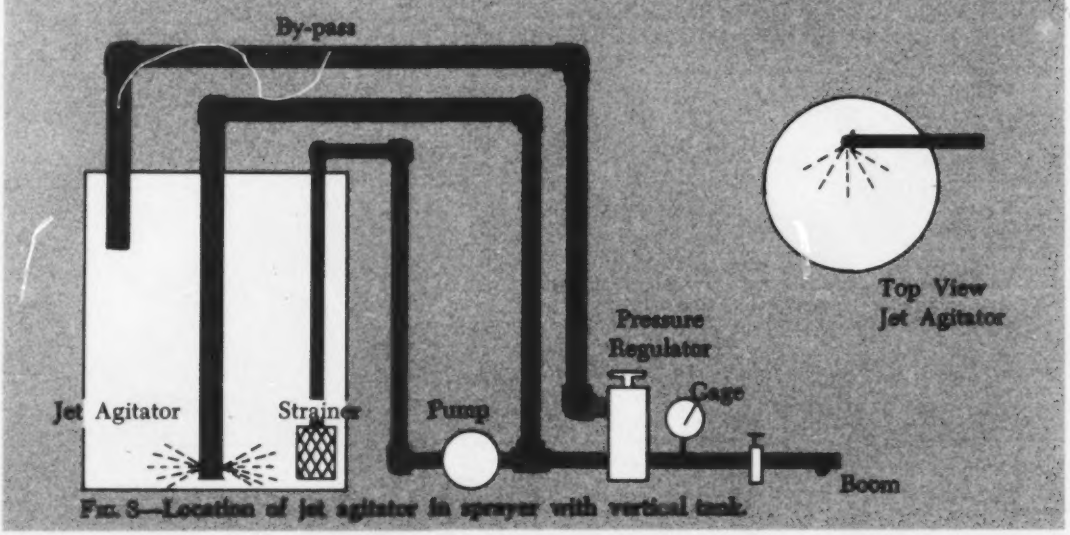


FIG. 3—Location of jet agitator in sprayer with vertical tank.

the pressure regulator. Most of the pressure is lost in passing through the regulator. The job of the bypass regulator is to regulate the pressure on the boom, and to prohibit excessive back pressure on the pump and system when the boom is shut off. Pumps can be severely damaged and regulator troubles develop if the bypass regulator line is restricted in any way.

Jet diameters must be large enough to provide a minimum flow of 3 gallons per minute for each 50 gallons of tank capacity. Table IV lists the jet hole sizes and the number of gallons per minute they will pass.

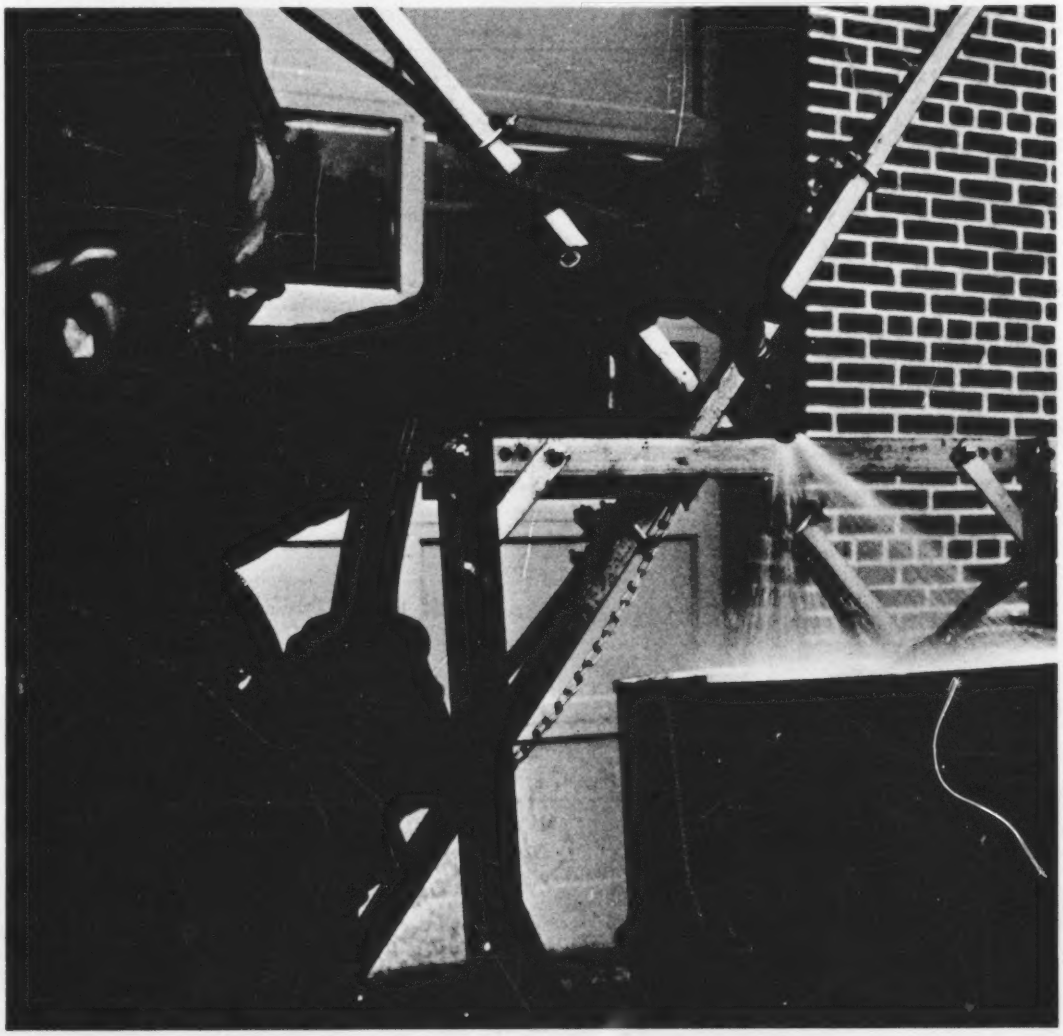
Be sure that jet flows pass through at least 12 inches of solution before they strike the side of the tank. A high velocity jet stream of wettable powder will wear a hole in the tank unless it passes through sufficient solution.

TABLE IV

Jet Diameters

	---- at 35 lb/sq in ----			
Hole size (inches)	1/16	3/32	1/8	5/32
Gallons per minute	1.00	1.45	2.55	3.84

Thoroughly hose down the tank, both inside and outside, to remove pesticide after each day's use.



Cleaning

After each day's use, thoroughly flush with water, both inside and out, to prevent accumulation of chemicals.

Choose your cleaning area with great care. It is important to discharge the cleaning water where it will not contaminate water supplies, streams, crops, or injure other plants, and where puddles will not be accessible to children, livestock, pets, or wildlife.

When you change chemicals, or finish spraying for the season, clean the sprayer thoroughly both inside and out.

The following steps are suggested for thorough cleaning:

1. Hose down the inside of the tank completely, filling it half full of water. Then flush out the cleaning water through the nozzles by operating the sprayer.

2. Repeat the procedure in step 1.

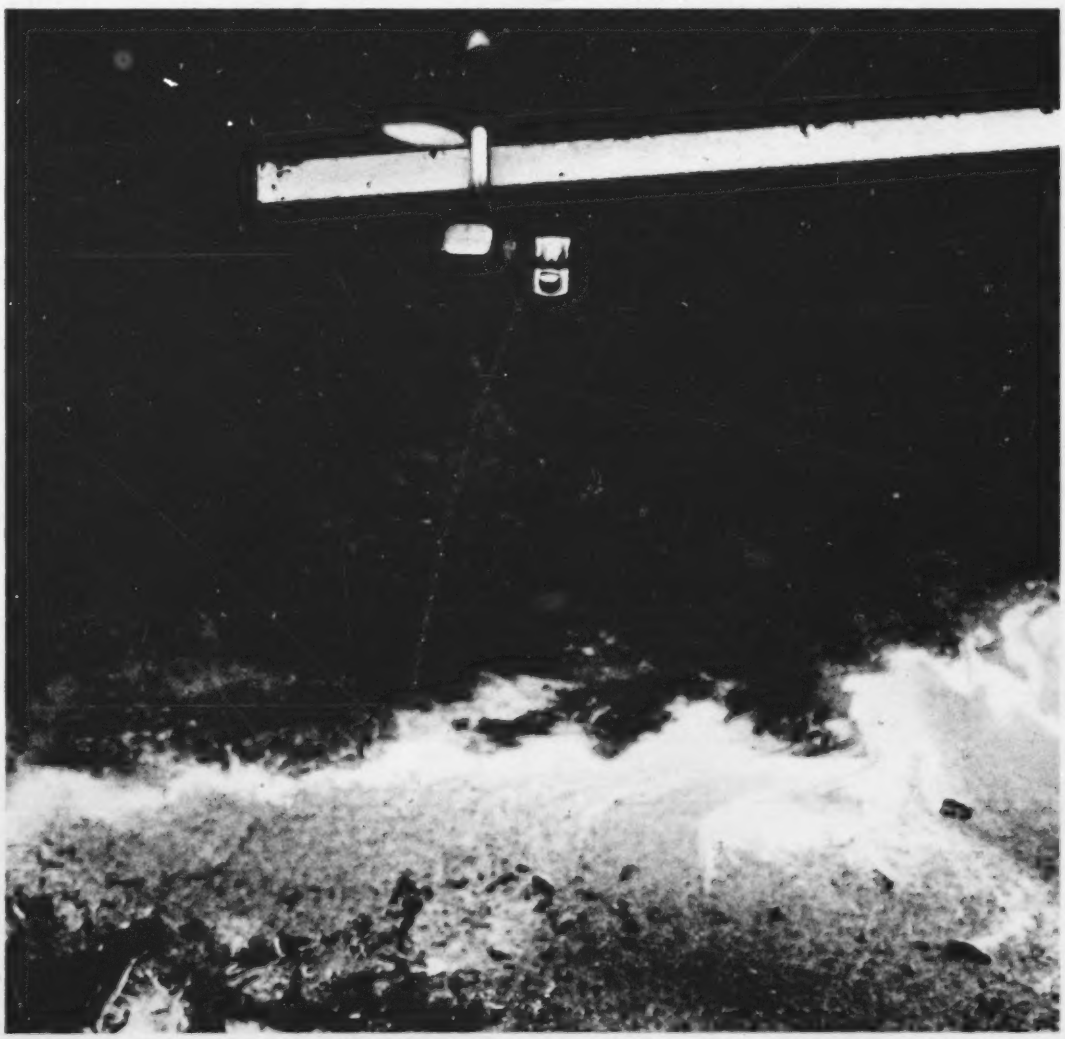
3. Remove nozzle tips and screens. Clean them in kerosene or detergent solution using a soft brush. Do not use a knife, wire, or other hard material to clean nozzle tips. The finely-machined surfaces of the tips can be easily damaged, causing distortion of the spray pattern and an increased rate of application.

4. Fill the tank about half full of water and add about 1 pound of detergent for every 50 gallons of water.

5. Operate the pump to circulate the detergent solution through the sprayer for about ½ hour, then flush it out through the boom.

If you have used 2,4-D or an organophosphorous insecticide, before doing step 6, follow

Discharge cleaning water where it will not form puddles that could harm people, animals, or plants.



this additional procedure:

a. Replace the screens and nozzle tips.

b. Fill the tank about half full of water and add 1 pint of ammonia for every 25 gallons of water.

c. Operate the pump to circulate the ammonia solution through the sprayer for about 5 minutes, and discharge a small amount through the boom and nozzles.

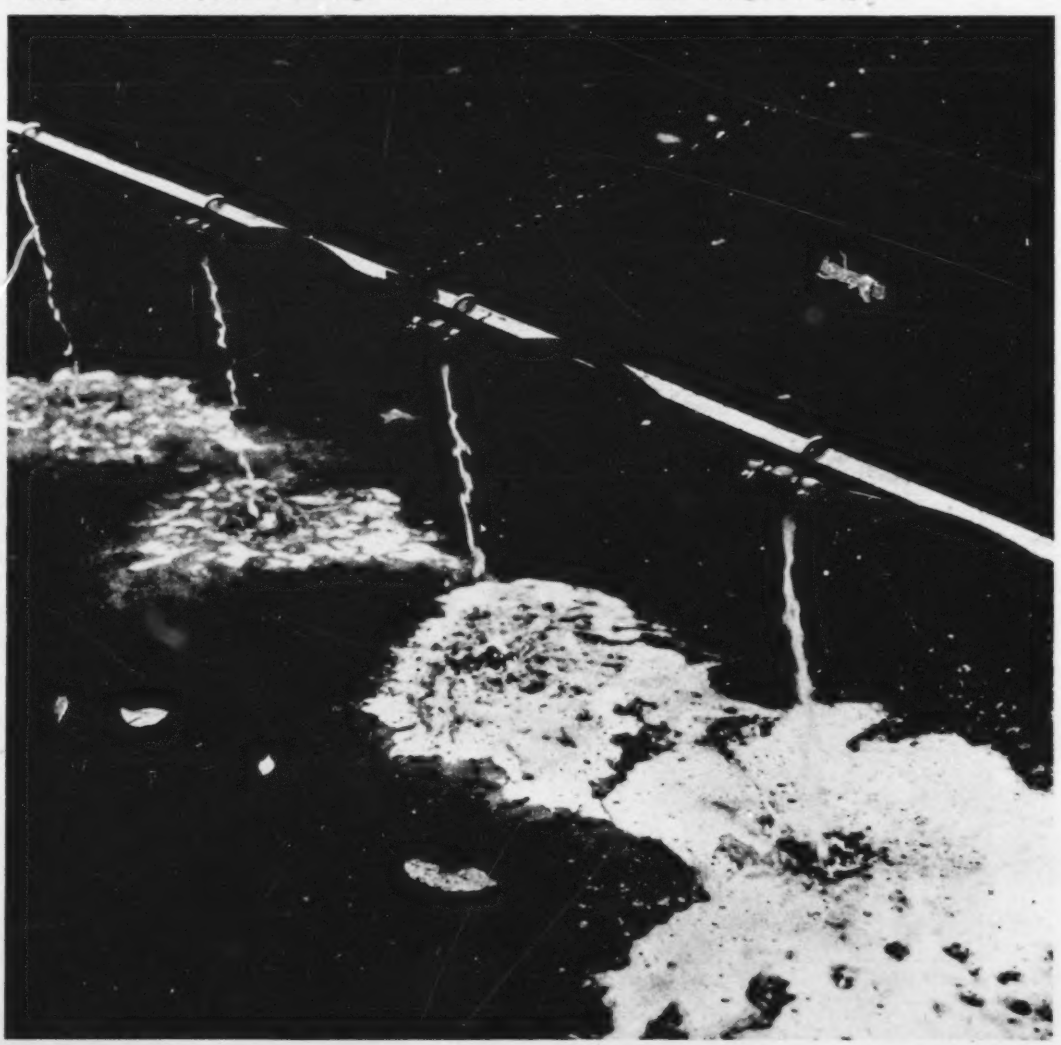
d. Keep remaining solution in the sprayer overnight.

e. In the morning, flush out all the ammonia solution through the nozzles by operating the sprayer.

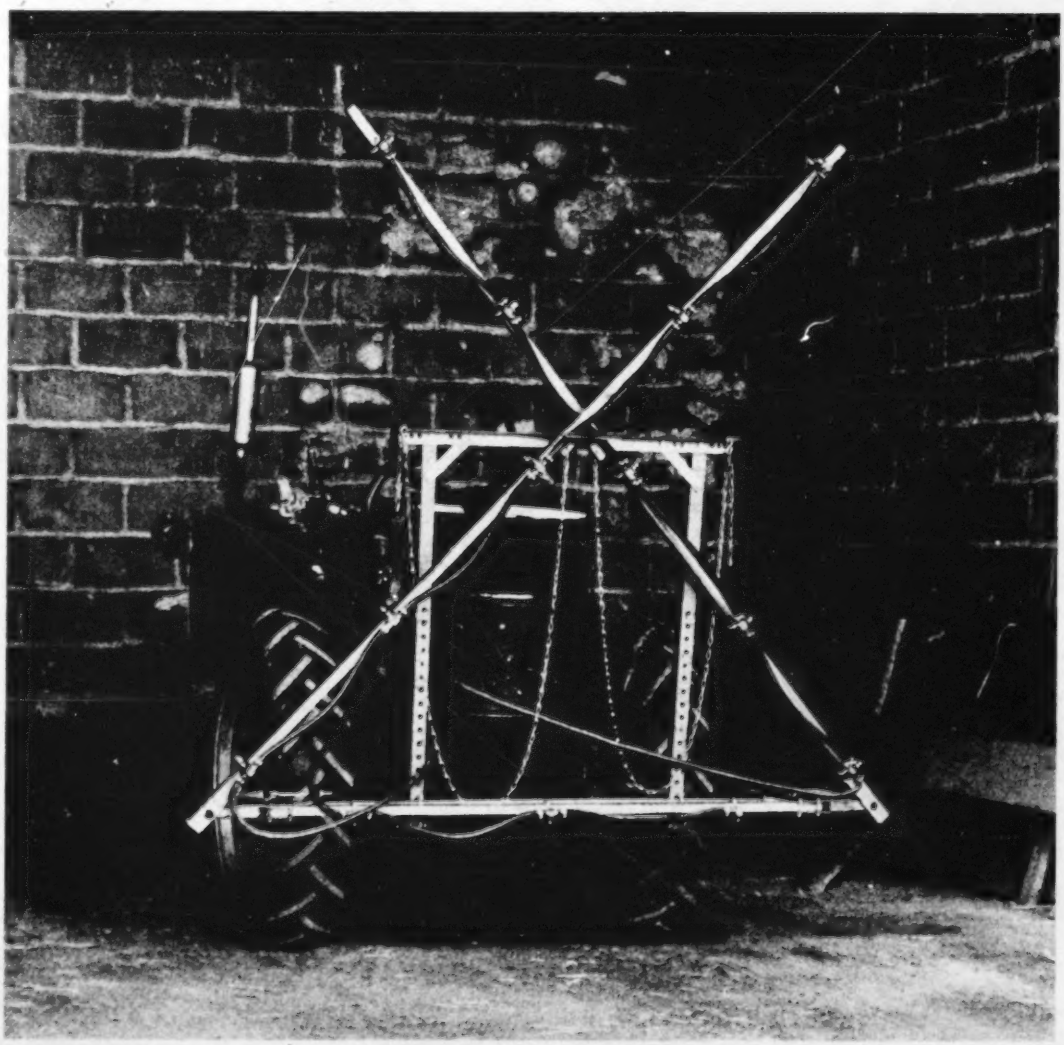
6. Fill the tank about half full of clean water while hosing down both the inside and outside, then flush out through the boom.

When finished with the sprayer for the season, remove and store the nozzle tips, strainers and screens in light oil. Store the sprayer in a clean, dry shed. If the pump cannot be drained completely, store where it cannot freeze.

Detergent solution is flushed out through nozzle outlets after it is circulated through the sprayer.



After cleaning is completed, store the sprayer in a clean, dry shed.



Warning

Use pesticides only when necessary.

Use pesticides only at the recommended dosages and timing to keep residues on crops and animals within the limits set by law.

Avoid spray or dust drift to other crops. Cover food and water containers in livestock areas.

Read the label and follow the safety precautions stated.

Wear protective masks and clothing if so directed on the label.

Avoid inhaling pesticides. Never eat or smoke while spraying or dusting.

Avoid spilling spray materials on skin or clothing. If spilled, wash off immediately with soap and water.

Wash hands and face and change to clean clothing after spraying or dusting. Wash spray clothing after each day's use.

Store pesticides in original containers and out of the reach of children, pets or livestock and away from food or feed. Use a well lighted store room so the labels can be read and lock the door between uses.

Dispose empty containers so that they are no hazard to man, especially children, and animals.

Do not contaminate streams, ponds, or other water sources.

If poisoning symptoms develop from pesticides, medicines or any other poison source, show your physician a label of the material involved. He can phone one of the Poison Control Centers for complete information as to treatment.

before using any pesticides read the precautions

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